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Mines, Migration and HIV/AIDS in Southern Africa

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Abstract

Swaziland and Lesotho have the highest HIV prevalence in the world. They also share another distinct feature: during the last century, they sent a large numbers of migrant workers to South African mines. This paper examines whether participation in mining in a bordering country affects HIV infection rate. A job in the mines means leaving for long periods away from their families and living in an area with an active sex industry. This creates potential incentives for multiple, concurrent partnerships. Using Demographic and Health Surveys, the analysis shows that migrant miners ages 30-44 are 15 percentage points more likely to be HIV positive, and women whose partner is a migrant miner are 8 percentage points more likely to become infected. The study also shows that miners are less likely to abstain or use condoms, and female partners of miners are more likely to engage in extramarital sex. The authors interpret these results as suggesting that miners' migration into South Africa has increased the spread of HIV/AIDS in their countries of origin. Consistent with this interpretation, the association between HIV infection and being a miner or a miner's wife are not statistically significant in Zimbabwe, a country where the mining industry is local and does not involve migrating to South Africa.

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Mines, Migration and HIV/AIDS in Southern Africa

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1. Introduction

The HIV/AIDS pandemic is one of the greatest challenges facing Africa. According to UNAIDS (2009a), in 2008, 22.4 million people were infected with HIV/AIDS in Sub–Saharan Africa (about 67 percent of the world total), 1.4 million died from the virus, and approximately 1.9 million became newly infected. Swaziland and Lesotho are the countries with the highest HIV prevalence rate in the world. Recent nationally representative estimates reveal an adult HIV prevalence equal to 26% in Swaziland (Swaziland Government and ORC Macro, 2008) and to 23.2% in Lesotho (Lesotho Government and ORC Macro, 2005).[3]

These countries have two main features in common: they are small countries bordering South Africa (see figure 1) and, during the past decades, they were exposed to massive recruitment to work in South African mines. For more than a century, 90 percent of those employed in the mining sector in the Republic of South Africa were black and about 60 percent were migrant workers from Lesotho and Swaziland (Lucas, 1985; Harington, McGlashan and Chelkowska, 2004). This evidence poses a crucial and still unanswered question in the economic literature: is there a relationship between the proportion of migrant miners in a country and HIV infections?

This paper investigates whether the massive percentage of migrant workers employed in South Africa's mining industry for a long period in the past might be one of the main explanations for the high HIV prevalence observed in Swaziland and Lesotho. We hypothesize that mining activities might influence the risk of HIV infection through three main channels. First, working in South African mines implies temporary long-term migration from the household of origin and this increases the probability of engaging in multiple concurrent sexual partners. Second, miners have traditionally been accommodated in single-sex hostels and this has boosted an active sex industry in the area surrounding the mining sites where miners have disposable income to engage in sexual relationships with commercial sex workers. Finally, women, who wait for their husbands to come back from the mines, might be more likely to engage in sexual relationships with other partners as well.

The data used in the paper come from the Demographic and Health Survey (DHS) conducted in Swaziland (2006-2007) and Lesotho (2004). In this set of African countries, the DHS provides the information required for our empirical analysis: a complete standardized questionnaire on socio-demographic characteristics and HIV test results for a nationally representative sample of the adult population. The latter represents a great advantage compared to previous surveys that collected information on HIV/AIDS based exclusively on self-reported behaviors.

To analyze the relationship between migrant miners and HIV status, we estimate a *probit* model for the probability of being HIV positive and adopting the safer sexual behaviors promoted

[3] Botswana is also considered one of the countries with the highest HIV prevalence in the world. The available and most recent data on HIV prevalence in Botswana reveal an HIV prevalence equal to 24.8% (UNAIDS, 2009b). This data comes from Sentinel Surveillance Surveys among pregnant women attending antenatal clinics but are not nationally representative. Because there is no recent DHS survey with HIV testing for Botswana, we cannot include it in the analysis.

by the so-called "ABC campaign" (Abstinence, Be faithful and use a Condom), a strategy developed in response to the HIV/AIDS pandemic in Africa. Our key independent variable is a dummy equal to one if a male respondent declares work in the mines as his main occupation or if a female respondent has a miner as a husband/cohabiting partner.[4] In the empirical analysis, we attempt to address the potential endogeneity of the miner status by augmenting the baseline specification with additional controls, capturing unobserved omitted variables correlated with the probability of becoming a miner and being infected with HIV. In particular, we control our estimates for the individual's propensity to spend time away from the household of origin.

We find that miners and women with a miner as a partner are the groups most vulnerable to HIV/AIDS in Lesotho and Swaziland. Ceteris paribus, being a miner aged 30-44 years old increases the likelihood of being HIV positive by 15 percentage points. Another interesting and previously unexplored result shows that having a partner employed in the mines increases the probability of infection for women by approximately 8 percentage points. Using Zimbabwe (2005-2006) as a comparison country (Zimbabwe Government and ORC Macro, 2007), where the mining industry is well-developed and miners do not need to migrate to another country, we attempt to understand whether these effects are driven by the mining activities themselves or by the migration pattern towards South Africa's mines. We find no statistically significant association between mining activities and HIV prevalence in Zimbabwe, suggesting that the migration to the mines plays a relevant role in HIV propagation.

Furthermore, results show that being a migrant miner or having a miner as a partner is strongly correlated with risky sexual behaviors. The estimates reveal that miners and women with a partner employed in the mining sector are less likely to abstain from sex in the last year, compared to individuals with other types of jobs. We also find that women with a miner as a partner are more likely to engage in extra-marital sex during their husbands' absence. Additionally, miners are less likely to use condoms, especially during extra-marital relationships, and having a miner as partner decreases the probability of using a condom for women within the marriage. These results suggest an important source of vulnerability: married women are less likely to use a condom within marriage with their miner husbands than married women not married with miners and miners are less likely to use condoms when they have extramarital sex. This low level of protection during sexual intercourse is likely to increase the risk of HIV transmission.

The determinants of the high HIV prevalence in Africa have received much attention in the development economic literature. The most straightforward explanation is differences in sexual behaviors, either in the number of partners (Kapiga and Aitken, 2002; Hunter 1993) or in the sexual mixing patterns (Morris and Kretzschmar, 1997). Previous studies have also suggested that the difference in HIV prevalence between Sub-Saharan Africa and other countries is due to differences in the incidence of other sexually transmitted infections (STI) and, consequently, in different HIV transmission rates (Over and Piot, 1993; O'Farrell 2001; Oster 2005). Furthermore, there is literature studying HIV rates among high risk groups, such as people who have been in successive marriages (de Walque and Kline, 2012), commercial sex workers (Abdool Karim et al., 1995; Nagot et al., 2002; Ramjee et al., 2005) and truck drivers (Lurie et al., 2003). Finally, a more recent strand of the literature argues that mobility might be a key factor contributing to the fast spread of the

[4] Mining is traditionally a man's occupation. Women are not employed in the mining sector in Lesotho and Swaziland.

epidemic in Africa (Coffee, Lurie, Garnett, 2007; Lurie et al., 2003; Brewer et al., 1998). Oster (2011) shows how exports affect the incidence of HIV in Africa and she interprets these results as evidence that increased exports increase the movement of people, which increases sexual contacts. Similarly, Djemai (2009) observes that living in close proximity to a major road increases the individual risk of infection, suggesting that trade along roads and displacement of people contribute to HIV propagation. More similar to our work, some epidemiological studies assess the prevalence of occupational illnesses among the workforce employed in South African mines, such as tuberculosis, silicosis, HIV/AIDS and lung disease (Leger 1992; Steen et al. 1997; Corbett et al. 2000). Ress et al. (2009) discuss the role of oscillating migration from the gold mines of South Africa and the neighboring countries in fuelling silicosis, tuberculosis and HIV infection. While they provide a detailed review of the literature, they do not test empirically the relationship between migration toward the mines and HIV infection.

This paper makes several contributions. First, it complements the literature that tries to understand the reasons for the high prevalence of HIV/AIDS in Sub-Saharan Africa. Even though the mining industry represents a large fraction of the economy in many African countries, little is known about the association between mining activities and HIV prevalence. This paper is among the first to explicitly test this relationship. Second, we highlight a group at high risk for HIV infection overlooked in the previous literature, namely the wives/partners of the migrant miners. From a policy perspective, this is important because it sheds light on a new potential focus for HIV prevention programs. Third, although much of the paper is devoted to establishing a link between mining activities and HIV infection, we also contribute to a better understanding of the socioeconomic profile of HIV/AIDS and related sexual behaviors. In this respect, we confirm the crucial role of education in preventing HIV infections and promoting safer sexual habits.

The paper is organized as follows. In section 2 we provide a background of the migrant miners' phenomenon towards South Africa. The data and the empirical methodology are discussed in section 3. Section 4 describes the main results and in section 5 we report some robustness checks. Finally, section 6 concludes.

2. Background

2.1 Migrant miners in South Africa

Mining is South Africa's largest economic sector and has been the main driving force behind the history and development of the country. Large scale and profitable mining activity started with the discovery of diamonds in the Orange River in 1867 and it rapidly grew with the discovery of other minerals such as gold**,** platinum, coal, chromium, iron, vanadium and uranium. During the 20th century, South Africa was the world's top producer of gold, gem diamonds, ferrochromium and platinum, representing approximately 88% of the world reserve base of platinum-group metals. South Africa was self-sufficient in the vast majority of its mineral needs, the bulk of which were produced in the northern half of the country (Encyclopedia of the Nations, 2011).

The size and the labor-intensity of the mining industry created job opportunities for the men of southern Africa, who have been, throughout the century, the major source of employees for the mining sector in the Republic of South Africa (RSA). Ninety percent of the 700,000 workers employed in the South African mines in 1980 were non-whites (Lucas, 1985). Due to their close

geographic proximity, the countries providing the most foreign labor have been Lesotho and Swaziland, followed by Mozambique and Botswana. Lesotho, because of the country's narrow resource base, sent the largest number of migrant workers in the mines. From 1986 to 1996, Basotho workers accounted for over 40 percent of the total labor force employed in the South African mining sector (Harington, McGlashan and Chelkowska, 2004).[5] Over this period, almost all able-bodied males could obtain a contract as a novice to work in the mining industry. Foreign workers were hired on contracts varying in length from six months to two years, according to their country of origin. Due to the restriction of movement legislated under Apartheid, foreign workers were not permitted to bring their families and, at the end of their contract, employees were required to return to their countries of origin. Non-white workers were recruited through a single agency called The Employment Bureau of Africa (TEBA).

[Insert figure 2]

The total number of migrant workers employed in the gold mines increased until 1987 (Crush and James, 1995). Since 1987, and particularly after the August 1987 miners' strike, this was no longer the case (see figure 2).[6] With the heightened opposition to South Africa's apartheid regime, the mechanization in gold mining and the decrease in the price of gold, the number of migrant miners have dramatically declined. The total number of workers employed in Wage Bands 1-8, the categories historically reserved for black workers, fell from 546,112 in 1986 to 327,305 in 1993, a decline of about 40 percent of the 1986 total (Crush and James, 1995). After this retrenchment, there was a very limited re-employment of former miners in their country of origin because of their high level of illiteracy, suggesting a potential correlation between former miners and currently unemployed people.

Mining in South Africa now accounts for about 7.3% of the GDP, down from around 14% in the 1980s (OECD, 2007). Having been the world's biggest gold producer for more than a century, South Africa has fallen behind China, Australia and the United States. Some of its mines are nearing the end of their productive lives. But gold continues to be an important contributor to the economy, earning 49 billion rand (about 6 billion US$) in foreign exchange in 2009. That makes gold the country's second-biggest export after platinum, where South Africa is the global leader (The Economist, 2010).

Within Lesotho and Swaziland, the contribution of mining to the economy has been very limited thus far. In Lesotho, most of the initial feasibility studies conducted at the exploration stage showed that diamond mining could not be sustained and commercialized. The oldest diamond mining site, the Letseng diamond pipe, was officially opened in 1977, but then closed after five years because of the diamond market recession. Mining's role in Swaziland's economy has been declining over the years, accounting for only 1.4 percent of the GDP in 2000/01. On the contrary, in Zimbabwe,

[5] The historical origins of the Basotho labor migration phenomenon dates as far back as the formation of Lesotho as a nation (circa 1824), when most of the Lesotho workforce found employment in the South African agricultural sector. This period was characterized by the movements of families as opposed to male-labor movements. With the discovery of diamonds in 1867, male Basotho employees began to be so numerous that the RSA authorities started to enforce policies aimed at alienating black workers. Thus, a series of regulations and laws essentially prohibiting permanent residence of black persons in the RSA's urban areas had been promulgated. The upshot of these regulations has been to make black mineworkers oscillate between their home country (where their families are based) and the RSA's areas of employment (Central Bank of Lesotho and Bureau of Statistics, 1995).

[6] The 1987 nationwide strike involved more than 300,000 black miners and it raised the spirits of the anti-apartheid movement against white domination (Battersby, 1987).

mining was the leading industry until 2000, contributing 27 percent of export trade. In 2000, the role of the mining sector sharply declined, due to a contracting economy, high unemployment, and a 60 percent inflation rate. For the first time in 20 years, production in the major commodities, including gold declined by 17–60 percent (Encyclopedia of the Nation, 2011). After years of decline, the Zimbabwean production output of the country's mining sector is recovering and it reached 13.3 percent of the GDP in 2008 (The Chamber of mines of Zimbabwe, 2011).

2.2. Miners' migration and HIV infection

A combination of factors suggests a potential positive correlation between labor migration in the mines and the risk of being infected with the HIV virus. Some factors are linked to the migration phenomena itself, some others are particular to the mining context, with crucial consequences for the spread of HIV/AIDS in South Africa and in the miners' country of origin.

First, mine migrants must reside away from their families for a temporary but long period of time. During these months, they may be more likely to have multiple concurrent partners, increasing their risk of being infected by the virus. Sexual relationships that overlap over a period of time increase the likelihood of person-to-person sexual transmission. This is due to extremely high viral loads during the first few weeks of HIV infection, the so-called acute infection period. Consequently, sexual networks characterized by concurrent relationships create an environment conducive to the rapid spread of HIV (NAC, 2009). Further, because their mining contracts span many months, miners and their longer-term girlfriends at the mining site may tend to trust each other and be less likely to use condoms than in a more casual relationship. After contracting the virus, they might infect their wives or long-term partners when they return to their country.

Second, miners have traditionally been accommodated in single-sex, regimented, company-owned compounds or hostels, located close to the mining sites. As a result of this situation, and because miners earn higher incomes, an active sex industry has arisen in the areas surrounding the South African mines. Commercial sex workers are a key group at high-risk for HIV infection and transmission (Abdool Karim et al. 1995; Nagot et al. 2002, Ramjee et al. 2005).

Third, mining is a very dangerous occupation and AIDS may be considered a distant threat compared to the more immediate dangers that miners have to constantly face during their daily job. This might raise barriers to behavioral changes, such as more frequent use of condoms with commercial sex workers.

There may be also an indirect relationship between migrant labor in the mines and HIV infection. Miners' wives or their long-term partners, who are waiting for their husbands to come back from the mines, may also engage in extra-marital sexual relationships.

The long absences from home, the dangerous work in the mines, and sex workers around the mining sites have created high-risk groups – namely miners and their partners – that have been overlooked in the literature thus far. These groups could be instrumental in spreading HIV/AIDS and other sexually transmitted diseases in Southern Africa.

3. The data: A descriptive analysis

The three datasets used for this study are nationally representative and come from the standard Demographic and Health Surveys (DHS) conducted in Lesotho (2004), Swaziland (2006-2007) and

Zimbabwe (2005-2006) (Lesotho Government and ORC Macro, 2005; Swaziland Government and ORC Macro 2008; Zimbabwe Government and ORC Macro, 2007).

In each country, the DHS uses a two-stage sampling design. In the first stage, the clusters are selected from a list of enumeration areas from the latest national census (e.g. the 1996 Lesotho Population Census). In the second stage, a complete listing of households is created in each selected cluster. In each household, randomly selected from the complete listing, all women aged 15-49 who were either usual residents or visitors present in the household on the night before the survey were eligible to be interviewed. For the male survey, only a fraction of the sampled households were selected. In this subsample, all men aged 15-59 years were eligible to be interviewed if they were either permanent residents or visitors present in the household on the night before the survey. Our final sample includes 9,892 individuals in Lesotho, 9,143 in Swaziland and 16,082 in Zimbabwe.

One of the great advantages of the DHS is that it includes HIV test results. All women and men eligible to be interviewed were asked to voluntarily provide a blood sample for HIV testing. The 2006-2007 Swaziland DHS estimated that 31.3 percent of women between 15-49 years and 19.5 percent of men between 15-59 years are HIV positive. These figures are slightly lower in Lesotho, with an HIV prevalence of 26 percent among women and 18.5 percent among men in the same age group. In Zimbabwe, DHS data report that 20.7 percent of women are HIV positive compared to 14 percent of men. The difference in HIV prevalence between genders is common to many other sub-Saharan African countries,[7] reflecting, on the one hand, a higher biological probability of transmission from men to women than from women to men and, on the other, a disparity due to sociological factors including economic resources and power differentials in sexual relationships.

HIV test results are missing for some individuals who were randomly selected to be tested in the survey because they refused to be tested, were absent or because of a technical problem. The proportion of people being tested is equal to 83 percent in Swaziland, 74.3 in Lesotho and 70 percent in Zimbabwe. Refusal to be tested is the main reason for the absence of a test.[8]

[Figures 3 and 4]

Figures 3 and 4 report the age profile for HIV prevalence for males and females in the sample. For both genders and in all countries, the age profile for HIV prevalence is hump shaped, first increasing and then decreasing with age. For women, the highest HIV prevalence is for individuals between 25 to 39 years old, while for men it is more tilted toward older ages (to the right) and is highest for men approximately between 30 to 44 years old. Interestingly, the graph also shows that HIV prevalence is considerably higher among young women than among young men. Multiple studies have suggested that this discrepancy might be explained by adult men's unprotected sexual relationships with younger girls (Laga et al., 2001; Luke and Kurz, 2002; Kelly et al. 2003; Dupas 2011). Indeed, older men may be more likely to be HIV infected compared to younger men, because they have been sexually active for longer and they generally have a higher income to

[7]For example, HIV prevalence in Ghana is 2.7% for women and 1.5% for men (Ghana and ORC Macro 2004). The corresponding figures for Kenya are 8% and 4.5% (Kenya and ORC Macro 2009) and for Malawi are 13% and 10% (Malawi and ORC Macro 2005).

[8] See Corno and de Walque (2007) for additional details related to the HIV testing sample selection in the Lesotho DHS.

negotiate (unprotected) sex. The peak of HIV prevalence is at older ages in Zimbabwe (at 35 to 39 years for women and at 40 to 44 years for men), compared to Lesotho and Swaziland. That peak is generally earlier for women than for men, with the exception of Lesotho, where the highest HIV prevalence rate is recorded in the age group between 30-34 years among men (41%) and in the age group between 35-39 years for women (43%). This figure may reflect an earlier sexual debut of Basotho males.[9]

[Insert table 1]

The DHS investigate the main type of occupation in the male sample and the partners' main type of occupation in the female sample. More precisely, in the latter, the survey asks the husband's/partner's occupation to currently married or cohabiting women or the last husband's/partner's occupation to formerly married women, widowers or formerly cohabiting couples. By construction, we do not have information about the partner's occupation of women who never married or never cohabited. Unfortunately, the questionnaire did not elicit information on the last type of job for unemployed respondents and unemployed partners. Table 1 shows HIV prevalence rates, by employment status for men and women's partners in the sample. The type of occupation is defined similarly across surveys and it allows a comparison of HIV prevalence by employment status across countries.

When pooling the observations for Lesotho, Swaziland and Zimbabwe, approximately 4 percent of the sample currently works in the mines. The most prevalent occupation is self-employment in agriculture (15.45 percent), followed by skilled manual jobs (14.19%) and occupation in the service sector (6.78 percent). The fraction of unemployed respondents is massive and almost equal to 40 percent. Looking at the sample of women, the fraction of unemployed partners decreases at 10.2 percent and working in the mines is the most common type of occupation (14.9 percent) after self-employment in agriculture (17.2 percent). The discrepancy between the fraction of miners in the men sample and the fraction of partners working in the mines in the women sample likely reflects the absence of miners during the survey. Indeed, as previously highlighted, DHS enumerators selected individuals present in the household in the night before the survey and, due to their temporary migration to South Africa, miners are obviously less likely to be present. Therefore, the proportion of miners might be severely underestimated and the sample of interviewed miners not fully representative.[10] We also expect a fraction of former mineworkers among the unemployed respondents. Indeed, as stated in the previous section, the average low level of formal education among formerly miners limited their chances to be employed in other occupations. The highest share of miners is recorded in Zimbabwe (4.95 percent), while the highest fraction of women with a partner employed in the mines is in Lesotho (31.5 percent). The mining activities are different in Lesotho and Swaziland compared to Zimbabwe, which is characterized by

[9]In Lesotho, the average age at the first sexual relation is 15 years old for men and 17 years old for women (author's calculations based on Lesotho Demographic and Health Survey, 2004).

[10]For example, data from the Lesotho Census 1996 reveal a fraction of male miners equal to 10%, while the same figure collected during the Census 2006 is equal to 4.8 %. Given the decreasing number of miners over time (see figure 2), we would expect a percentage of miners in Lesotho in 2004 between 10% and 4.8%, at least two times higher than the percentage of miners estimated in the Lesotho DHS (3.1%).

a local industry where miners do not need to migrate to South Africa to be employed. Zimbabwean miners are hence more likely to be present during the survey.

In table 1, in addition to the fraction of employees in each sector, we report the percentage of HIV infections by respondent's occupation. In the pooled sample, mining is, among the other skilled manual jobs, one of the occupations with the highest HIV prevalence rate (21.7 percent). The fraction of HIV positive respondents is even greater when we consider the sample of women: among 15 percent of women with a miner as a partner, 35 percent are HIV positive, representing the highest HIV infection rate among women. By looking separately at the three countries, the highest HIV prevalence is recorded among Basotho mineworkers, where HIV prevalence reaches 40 percent. These statistics are similar when we consider the sample of Basotho female respondents. About 36 percent of women who have a miner as a partner are HIV positive. A greater prevalence is only recorded among women with partners working as salesmen (40.8 percent) or in other skilled manual occupation (39.1 percent). The fraction of HIV positive individuals among miners ranged from 18 to 20 percent in Swaziland and Zimbabwe. The percentage of HIV infected women with a partner working in the mines is greater, with approximately 43.4 percent in Swaziland and 30 percent in Zimbabwe.

The descriptive analysis conducted so far provides an important initial piece of evidence that should be considered when designing HIV/AIDS prevention policies. Not only miners may have a higher risk of HIV infection, but also women who have miners as their partners.

[Insert table 2]

Table 2 reports summary statistics on the variables of interest by gender. The “pooled sample” includes Lesotho and Swaziland only because in the empirical analysis we will first show results for Lesotho and Swaziland and subsequently compare them with Zimbabwe. In addition to HIV infection, we use behaviors and attitudes related to HIV prevention as dependent variables, such as abstinence, extra-marital sexual relationships and condom use. These sexual behaviors are at the heart of most prevention efforts, including the so-called "ABC" strategy ("Abstain, Be Faithful and use a Condom"), the most widespread information campaign on HIV prevention in many African countries. Abstinence, defined as not having any sexual intercourse in the last year, is generally higher for men than for women and is much lower in Lesotho than in the other countries. More precisely, the survey reports that about 34 percent of men and about 30 percent of women had no sexual relationships in the last year. This may be driven by the fact that men tend to marry later. Indeed, while the survey does not include age at first marriage, we observe that the average age for currently married men in the sample is 37 years, compared to 31 years for women.

Extra-marital intercourses, measured with an indicator equal to one if currently married respondents have at least one sexual relationship outside the marriage in the last 12 months, are frequently reported in all three countries and are more than 10 percentage points greater for men than for women. The highest percentage of extra-marital relationships is reported in Lesotho: figures from the DHS suggest that 29.8 percent of currently married men and 12.7 percent of currently married women had non-marital sexual relationships in the last year.

We also have information about condom use: the survey investigates condom usage at last intercourse for Swaziland and Zimbabwe, while in Lesotho it elicits information on the last contraceptive method used in the males sample and on condom usage during the last intercourse in the females sample. Looking at the pooled samples of Lesotho and Swaziland almost 33 percent of men report using condoms during their last sexual intercourse compared to 26 percent of women. Condom use is much lower in Lesotho than in the other countries, except for women in Zimbabwe, where the share of respondents using condoms is very low and equal to 8 percent. Another great advantage of the DHS is that it investigates whether the last intercourse occurred with a spouse or with another partner. Hence, we can compare condom use inside and outside the marriage. As expected, the fraction of currently married respondents reporting condom with a spouse is low, ranging from 8 percent in Lesotho to 28 percent in Swaziland for men and from 3.3 percent in Zimbabwe to 22.7 percent in Swaziland for women. A much larger share of people report using condoms outside marriage, with the highest averages recorded in Swaziland.

Turning to the analysis of the independent variables, the share of miners in the sample is equal to 3 percent and the fraction of women with a miner as partner is almost eight times larger. The average age of individuals is 28 years while the average age of the partner in the women sample is much higher and equal to 38 years. Except for Lesotho, where women have the highest educational level of achievement, the average years of education are similar across genders in all the three countries. The share of the urban population is lower in Lesotho compared to Swaziland and Zimbabwe. The analysis uses a set of indicators for durable goods held by the household (television, radio, refrigerator, motorbike, car, bicycle, electricity) as a proxy for wealth. Indeed, the wealth quintiles provided in the DHS can be misleading as a measure of wealth, particularly for African countries: there is generally too little variation in the lowers three quintiles and differences in living standard are difficult to distinguish in those quintiles. Religious affiliations have been regrouped into three categories, Catholic (Roman Catholic Church), Protestant (Evangelical, Methodist, Anglican, Adventist, Pentecostal, other Christian) (the omitted variable in the regressions) and no religion. Finally, in the empirical analysis, we also include two variables capturing individual preferences to spend time away from the household of origin. The first one is a continuous variable indicating the number of nights male respondents have spent away from the household. The second one is a dummy capturing whether the husband lives in the household or not.

4. Methodology and potential sources of bias

The goal of the empirical section is twofold. First, we assess whether individuals working in the mining sector have a higher probability of being HIV positive and if women, with a partner employed in the mines, are at higher risk of being infected with HIV. Second, we test whether miners and miners' partners are more likely to report risky sexual behaviors compared to individuals with other types of jobs. We run two separate sets of regressions. The first set of equations uses the probability of being HIV positive as the dependent variable. The second one considers sexual behaviors, which are assumed to have an influence on the risk of HIV infection, such as abstinence, extra marital sex and condom usage, as dependent variables. Sexual behavior

and other practices are all self-reported. This is an obvious but inescapable limitation.[11] We estimate the following model:

$$Pr(Y_{ij}=1)=\Phi(\beta_0+\beta_1 Miner_{ij}+\beta_2 X_{ij}) \qquad (1)$$

where Φ is the Normal cdf, $Y_{ij}=1$ is the outcome of interest: a dummy equal to one if the individual *i* in country *j* is HIV positive or adopts risky sexual behaviors. $Miner_{ij}$ is a binary variable taking value one if *i* is a miner (in the men sample) or has a miner as a husband/partner (in the women sample). X_{ij} represents a set of individual characteristics including age, age squared, education, religion, as well as household features, such as location (urban and regional dummy variables), and wealth, measured by the amount of durable goods owned by the household. Age and age squared are included since HIV infection has a distinct hump-shaped profile (figures 3 and 4). Location variables account for the fact that the risk of HIV infection depends on HIV prevalence in an individual's sexual network, which is location specific. At the same time, location might determine access to prevention messages and methods such as condom use. Religion might also influence the type of sexual practices considered acceptable by an individual. Finally, education and wealth might provide better access to prevention messages and methods.

Although common in the epidemiologic literature, this study does not enter sexual behaviors as controls in the HIV infection regression. In a cross-section analysis, the estimates derived from such regressions would suffer from reverse causality and endogeneity. For example, condom use could prevent HIV infection (expected negative association) but people who are HIV positive might be more likely to use condoms to protect their partners (reverse causality going from HIV to condom use and potentially driving a positive association).

According to the empirical model, we should observe $\beta_1>0$ if, conditional on country and controls, the probability of being HIV positive or adopting risky behaviors is positively correlated with the status of miner. We estimate equation (1) with a *probit* model and we run separate regressions for men and women.

This estimation strategy deserves further comments. Our main independent variables, being a miner or having a miner as a partner, cannot be defined as completely exogenous to HIV infection and related attitudes. First, there could be unobserved omitted variables that explain both the probability of having HIV/AIDS and the probability of being a miner or choosing a husband employed in the mines. For example, miners could be individuals who enjoy spending time away from their households and this is correlated with a higher likelihood of having multiple sexual partnerships and, consequently, with HIV infection. Similarly, women who choose a husband working in the mines might prefer partners who are often away from the household and also have a preference for extramarital affairs. Second, there might be a problem of reverse causality since individuals, at a later stage of HIV infection might be less likely to work and, in particular, to perform tiring jobs such as mining. Finally, mining is a more risky occupation than many other professions. The same absence of fear for danger that led men to become miners might also lead

[11] Gersovitz (2005) discusses the issue of self–reporting sexual behaviors in the DHS and shows several inconsistencies, in particular regarding virginity and the age at first sexual intercourse. De Walque (2007a) also shows that the sexual behaviors reported by men and women in couples are not always mutually consistent, as in the case of condom use during the last sexual intercourse between two interviewed partners.

them to seek out risky sexual behaviors. These effects would lead to a bias in the coefficient β_1 in equation (1) estimated with a probit model.

Unfortunately, the data at hand does not offer any source of exogenous variations for the mining status. We attempted to address endogeneity with an instrumental variable approach, using the road distance between the DHS cluster locations and the cross border points with South Africa as an instrument for the probability of becoming a migrant miner. However, we were not confident that the exclusion restriction would be satisfied. Coefficients on miners and miners' partners should therefore be interpreted with caution and as associations rather than causal effects. In table 7 below, we attempt to identify possible controls capturing omitted variables both correlated with the likelihood of being a miner and with HIV infection. In particular, the control on which we will rely most is the presence of the husbands/partners in the household. This might allow us to proxy individual preferences to spend time away from the household.

5. Main results

5.1. HIV status

We next move to multivariate analysis to examine the association between HIV prevalence and mining activity. We first analyze the association between migrant miners and HIV infection for Lesotho and Swaziland. In these two countries, miners are always migrants since, as highlighted in section 2, Lesotho and Swaziland do not have a local mining industry. We will then focus on the case of Zimbabwe, where miners typically work within the country boundaries. The idea is to attempt to disentangle the effect of migration towards the mining sites versus the effect of mining activities per se on HIV prevalence.

[Insert table 3]

Table 3 shows pooled estimates for Lesotho and Swaziland in which the dependent variable is HIV status (zero for HIV negative and one for HIV positive individuals). In columns 1-4, we report results for the sample of males, while in columns 5-6 we consider women only. Marginal effects of probit coefficients are reported together with robust standard errors corrected for clustering of the residuals at the cluster level. Summary statistics of the variables used in the regressions can be found in table 2.

According to the estimates in column 1, being a miner is not significantly associated with HIV infection, when we control for additional socio-demographic characteristics. The coefficient loses its statistically significance once we include age and age squared among the regressors, suggesting that variation in HIV status is mainly explained by the age of the respondent. More precisely, the likelihood of being HIV positive first increases and then decreases with age, showing that individuals in the middle stages of their life are those most affected by HIV. In Lesotho and Swaziland, men who reached tertiary education are less likely to be HIV positive compared to those without education, while primary and secondary school does not seem to be an important factor in reducing HIV infections. This finding is particularly interesting because the question of the effect of education on HIV infection has different answers depending on the countries and the settings analyzed. For example, an analysis of five Demographic and Health Surveys in Burkina Faso,

Cameroon, Ghana, Kenya and Tanzania did not find any correlation between HIV and education (de Walque, 2009), while in a rural cohort in Uganda a negative gradient between schooling and HIV infection appeared over time among young women (de Walque, 2007b). It is interesting to note that HIV and urban locations are significantly associated: living in an urban area increases the probability of HIV infection and the coefficient is statistically significant at one percent level. Ownership of durable goods, used as proxy for the level of wealth, tends to be negatively associated with HIV infection, suggesting that richer individuals are less likely to be HIV positive. Finally, religious affiliation does not have any statistically significant effect on the dependent variable.

In column 2, we restrict the sample to men aged 30-44, those who have, as shown in figure 2, the highest risk of infection. The coefficient on the "Miner" dummy is positive and statistically significant at the ten percent level. In term of magnitude, ceteris paribus, a miner is 15.3 percentage points more likely to be infected by the virus. This finding suggests that while it may be difficult to isolate a positive relationship between being a miner and HIV status in the overall population, it can be found in the age groups where HIV prevalence is generally higher.

In columns 3 and 4, we consider the subsample of currently married or cohabitating men. This represents approximately 35.8 percent of the male respondents. Married individuals may adopt different sexual behaviors compared to non-married individuals and it is important to understand how the determinants of HIV infection differently influence these subgroups of the population. While miners currently married are not more likely to be HIV positive, results in column 4 are consistent with those reported in column 2; miners currently married between 30-44 years old have a higher likelihood of being HIV positive compared to other currently married individuals of the same age.

Columns 5 and 6 show marginal effects of probit coefficients for the sample of currently married women. This fraction is equal to 48 percent of the female sample. Since the question on partner's occupation is asked only to currently married or cohabiting women and to formerly married women, the results reported in the tables below will always refer to the sample of currently or cohabiting women. According to the marginal coefficient in column 5 an important association emerges: the coefficient on "Partner Miner" is positive and statistically significant at the one percent level. To assess the magnitude of this effect, note that, ceteris paribus, having a miner as a partner increases the probability of being an HIV positive woman by 8.6 percentage points. This result is consistent with the channels previously suggested: women with a husband employed in the mines have a higher likelihood of infection because, on one hand, they have higher chances of having extra-marital sex when the partner is away from the family and, on the other hand, they are at risk of being infected by their husbands coming back from the mines. Interestingly, we note that the coefficient on the age of the partner is positive and statistically significant at the one percent level. Older partners have been sexually active for a longer period and they may have a higher likelihood of being HIV positive and, in turn, infecting their younger wives. The other controls maintain the same sign and magnitude as those estimated in the men sample. The "Partner Miner" dummy remains positive and statistically significant at the five percent level also after restricting the sample to women aged 25-39, those facing the highest HIV prevalence (column 6). In term of magnitude, ceteris paribus, women between 25-39 years old, with a husband employed in the

mining sector, are about 10 percent points more likely to be HIV positive compared to women with partners having other occupations.

[Insert table 4]

Table 4 reports separate estimates for Lesotho and Swaziland. Country-level regressions with HIV status as the dependent variable generally show results that are consistent with the pooled regression results in the previous table. However, because of the reduced sample size, some coefficients that were significant in the pooled regressions might be not significant in the country-level regressions.

The association between a job in the mines and HIV status is substantially stronger in Lesotho, where miners are approximately 10 percentage points more likely to be HIV positive compared to individuals doing other types of jobs. The magnitude of the coefficient more than doubles when we consider only individuals in the 30-44 age group and it increases by 3 percentage points for the sample of currently married men. In Lesotho, women whose partners are miners are 5 percent points more likely to be infected and this finding is robust for the sub-sample of women aged 25-39. In Swaziland, women with a husband employed in the mines are more likely to be HIV positive, while miners do not seem to be more likely to be infected with HIV compared to the rest of the population.

Looking at the other controls, HIV status is negatively associated with tertiary education for men in Lesotho, but not for women, while it remains negative and statistically significant both for men and women in Swaziland. Also, urban status shows the previously discussed positive coefficient in all the specifications.

5.2 Sexual behaviors related to the HIV/AIDS epidemic

Next, we examine a range of sexual behaviors (abstinence, extra-marital sex, and condom use) that are assumed to have an influence on the risk of HIV infection. The goal of this section is to better understand the risky sexual practices causing the strong association between mineworkers and HIV/AIDS.

[Insert table 5]

Table 5 reports marginal effects of probit coefficients for the probability of abstaining from sexual intercourses (columns 1-2) and for the likelihood of having extra-marital sexual intercourse (columns 3-4) in the last year. As before, we report separate estimates for men and women.

According to the estimates in column 1, the "Miner" indicator is negatively and statistically significantly associated with the likelihood of abstaining. The magnitude of the coefficient is substantial: working as a miner reduces the probability of abstaining in the last year by 9.8 percentage points and the coefficient is statistically significant at the one percent level. Looking at the other explanatory variables, the coefficient on age is negative while the coefficient on age squared is positive, suggesting, as expected, that younger and older individuals are more likely to abstain. Men living in urban areas are less likely to abstain. The other statistically significant coefficient is religion: Catholics are less likely to abstain compared to Protestants (the omitted category).

Column 2 reports estimates for the women sample. Once again, the "Partner Miner" coefficient is negative and statistically significant at the one percent level. In term of magnitude, ceteris paribus, having a partner working in the mines decreases the probability of abstaining from sexual intercourse by 1.4 percentage points. This finding confirms that women, with a husband temporarily employed in the mines, are less likely to abstain from sexual relationships, compared to women with partners doing other types of jobs. By analyzing the effect of other covariates on the dependent variable, we find that the age of the partner is positively associated with abstinence. Abstinence is also negatively correlated with wealth, showing that richer women are less likely to abstain.

In addition to abstinence, fidelity is considered another strategy for HIV prevention. In table 5, columns 3 and 4, we test whether being a miner or having a partner employed in the mines is associated with the likelihood of engaging in extra-marital sex. We report marginal effects of a probit model using the probability of engaging in extra-marital relationships in the last 12 months as the dependent variable. The estimates only consider the subsample of currently married or cohabiting individuals because the others, by definition, have only non-marital sex if they are sexually active. Column 3 shows that the coefficient on "Miner*"* is not statistically significant. This is a counterintuitive result and it is plausibly driven by the small fraction of currently married miners in the sample, which as previously discussed, is not representative of the total miner population. Among the other controls in the male regression, the statistically significant covariates are urban status and Catholic.

When considering the sample of women, an interesting result emerges: having a miner as partner is positively correlated with extra-marital sexual intercourses. More specifically, according to column 4, when the partner works in the mines, a woman is almost 2 percent points more likely to report extra-marital sex. This result is robust to the inclusion of controls such as age, age squared, urban status, education and wealth. Among the other findings, age positively influences the dependent variable, while the coefficient on age squared is negative, suggesting, as expected, that women in the middle stage of their life are more likely to report extra-marital affairs. Having older partners increases the likelihood of engaging in extra-marital relationships. Furthermore, educated women are more likely not to engage in extra-marital sex. The coefficient on assets owned by the household is negatively correlated with the dependent variable, suggesting that richer women are less likely to engage in extra-marital sexual affairs. Finally, Catholic women are more likely to engage in extra-marital relationships compared to Protestant.

[Insert table 6]

We next test whether, ceteris paribus, miners and women with a partner employed in the mines are less likely to use condom. The Swaziland DHS asks about condom use during the last intercourse to women and men in the sample, while in Lesotho, the survey investigates the last contraceptive method used by males and whether a condom was used at the last intercourse in the female sample. Furthermore, the survey elicits information on whether the last sexual intercourse occurred with a spouse or with another partner. This question is crucial to comparing prevention behaviors inside and outside the marriage.

Marginal effects of probit coefficients for the probability of using a condom are reported in table 6. The first notable result in column 1 shows that, after controlling for a large number of

individual and household characteristics, the coefficient on the "Miner" dummy is negative and significant at the one percent level. The magnitude of this effect is substantial: ceteris paribus, miners are about 12.1 percentage points less likely to use a condom. Notably, the probability of using a condom monotonically increases with educational achievement at all stages: having tertiary education increases the likelihood of using a condom during sexual intercourse by 25 percentage points. Among other controls, the urban residence of the respondent has a positive effect on the dependent variable: people living in urban districts are generally more exposed to information campaigns promoting the use of condoms and there is a higher availability of condoms in urban areas.

In columns 2 and 3, we examine the probability of using a condom during sexual intercourse with a spouse and with other partners. Married miners do not appear less likely to use a condom with their spouse compared to non-miners (column 2, negative but not significant coefficient). However, the negative coefficient on "Miners" is statistically significant at the one percent level and larger in magnitude for married and sexually active single men during extramarital relationships (column 3). Holding the other controls at the sample mean, miners are 17 percentage points less likely to use a condom with occasional sexual partners. As stated in section 2, a possible interpretation of this result is that long-term extramarital relationships might increase the trust between partners and therefore the use of condoms might not appear necessary anymore. Furthermore, the risky job performed in the mines might reduce the incentives for condom usage during occasional sexual relationships, since the fear of contracting AIDS is seen as a distant threat compared to the daily dangers faced by miners.

By analyzing the sample of women, estimates in column 4 show that having a miner as a partner decreases the likelihood of using a condom during the last intercourse by approximately 3.7 percentage points. Interestingly, in column 5, the association between condom use with a spouse and the "Partner Miner" indicator is negatively and statistically significant at one percent level. In the case of extramarital relationships, the association is also negative but not statistically significant, potentially because of the limited sample of married women who report extra-marital sex. This finding suggests a potential channel for HIV transmission: married women are less likely to use a condom within the marriage with their miner husbands compared to married woman not married with miners and miners are less likely to use condoms during extra-marital intercourse.

6. Robustness

6.1 Potential sources of endogeneity

The analysis conducted so far shows that miners (age 30-44) and women whose husband/partner is a miner are more likely to be HIV positive and less likely, on average, to adopt safer sexual behaviors. The main limitation of these findings is that the choice to become a miner or to have a miner as husband may be endogenous to HIV infections and other sexual behaviors, consequently affecting the causal interpretation of the β_1 coefficient in equation (1). For example, migrant miners may enjoy spending more time away from their families compared to non-miners and this preference may also be correlated with a higher probability of HIV infection, through multiple concurrent sexual partners.

While an empirical strategy fully dealing with the endogeneity of the "Miner"/"Partner Miner" variable is not possible with the data at hand, we test whether our results are affected when we take preferences for spending time away from the household into account. Formally, we augment the main specification reported in tables 3-6 with two regressors that capture the individual propensity to spend more time away from the family of origin. The variable "number of times away from the household" describes how many nights the male respondent was away from his household in the last year and the dummy variable "husband living elsewhere" takes value one in the females sample if the husband or the cohabiting partner is not currently living in the household. The estimated coefficients on these variables may suffer from endogeneity bias. For this reason they should not be given a causal interpretation. The purpose of including them among the controls is purely to test whether the correlation between migrant miners and HIV status is driven by a higher propensity to spend time away from the household.

[Insert table 7]

Estimates are displayed in table 7. A first notable result is that the coefficients on "Miner", aged 30-44, and on "Partner Miner" still positively affect the probability of HIV infection and the magnitude of the marginal effects are very similar to those estimated in table 3. These results increase the confidence that the estimated effects on HIV prevalence are actually associated with the status of being a miner or of having a miner as a partner. Similarly, in columns 5 and 6, we show that miners and women with a partner working in the mines are less likely to abstain, while they do not have any statistically significant effect on extramarital intercourses, in line with the results reported in table 4. In columns 9-14, we also investigate if our findings are robust to the inclusion of additional controls in the regression with condom usage as dependent variable. Once again, miners and women with a miner as a partner are less likely to use a condom, especially during sexual intercourse with a spouse in the women sample and with other occasional partners in the men sample.

6.2 Non-migrant miners: The case of Zimbabwe

In this section, we attempt to understand whether *miners* per se are more likely to be HIV infected or whether *migrant miners* have a greater chance of being HIV positive, consequently playing an important role in HIV transmission. Disentangling these channels is crucial for designing appropriate prevention policies. To this end, we estimate the probability of HIV infection for miners and for women having a miner as a partner in Zimbabwe. As described in section 2, Zimbabwe has a well-developed local mining industry and the miners interviewed in the Zimbabwe DHS are therefore likely to be local miners. The same argument may be applied to women with a miner as a partner. Indeed, figures from the DHS show that the fraction of partners employed in the mining industry that lives within the household of origin is 66 percent in Zimbabwe, while the same percentage decreases to 29 percent in Swaziland and to 23 percent in Lesotho (not displayed). Furthermore, figure 2 shows that the number of migrants from Zimbabwe working in the South Africa gold mines is very close to zero.

[Insert table 8]

Table 8 displays marginal effects of probit coefficients for the probability of being HIV positive in Zimbabwe. We note that the coefficient on "Miner" and "Partner Miner" is not statistically significant in all the specifications and that the point estimates are close to zero. These findings suggest that the estimated correlation between miner and HIV/AIDS is not due to the mines activities per se but to the combination of factors that characterized the migration of workers towards the mining sites.

A limitation of the paper is that we cannot rigorously distinguish the effect of migration itself from the effect of migration to the mining sites on HIV prevalence. Although previous literature finds substantial evidence on the correlation between migration and HIV (Coffee, Lurie, Garnett, 2007; Lurie et al., 2003; Brewer et al., 1998; Oster 2011, Djemai 2009), the non-significant coefficients on the number of nights spent away from the household reported in table 7 seems to point in the opposite direction. It seems that, in the context of Lesotho and Swaziland, the migration phenomenon per se does not influence HIV infection.

7. Conclusions

This paper examined whether the very high HIV prevalence recorded in Swaziland and Lesotho, 26% and 23.2% respectively, could be partially explained by the massive numbers of migrant miners who were employed in South Africa mines during the past century. Our results show that the likelihood of HIV infection increases for individuals employed in the mines in the age range between 30-44 years old. The paper also shows a previously unexplored finding: women who have a husband or a cohabiting partner employed in the mining sector are also more likely to be tested HIV positive.

Furthermore, miners and their wives are less likely to adopt safer sexual behaviors. More precisely, miners are less likely to abstain and to use condoms, in particular during occasional sexual intercourse. Similarly, women with a miner as a partner are less likely to abstain, to be faithful or to use condom with their miner husbands.

Lacking suitable exogenous variation, we first attempted to deal with the endogeneity of being a miner/having a miner as a partner by including additional controls that take preferences for spending time away from the household into account. Second, by using Zimbabwe as a comparison country, where the mining sector is well-developed within the country boundaries, we disentangled the effect of mining activities versus miners' migration on HIV infections. Results are consistent with the hypothesis that miners' migration into South Africa has increased HIV/AIDS transmission in its bordering countries. Although, our results should be interpreted as associations rather than causally, the paper documents strong correlation patterns that could be the focus of future research on mining activities and HIV prevalence.

Some of our findings directly suggest important implications for policies. Prevention efforts need to be reinforced within and around the mining sites. Wives and partners of men working in the mining sector would also benefit from being the focus of HIV prevention interventions.

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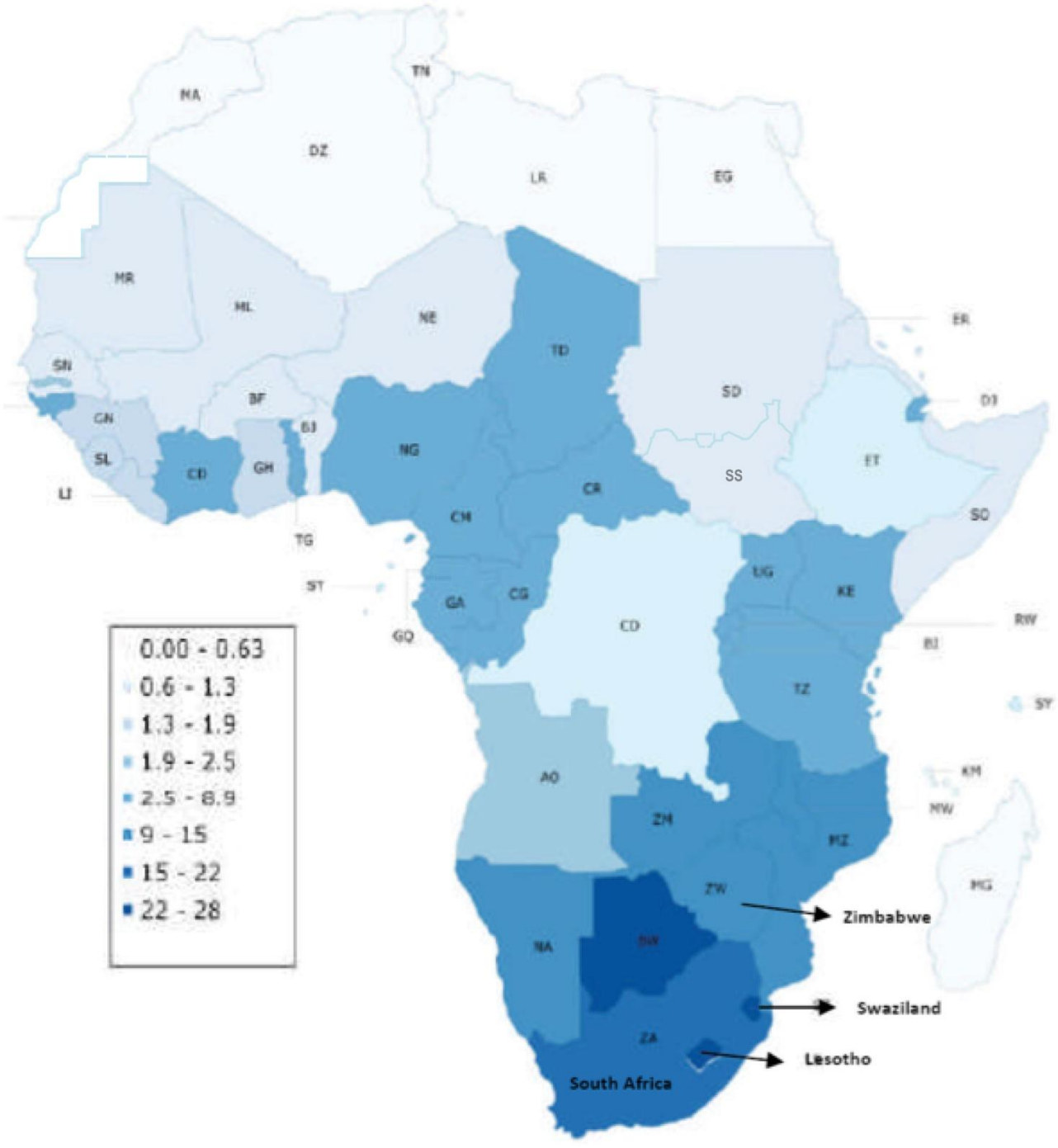
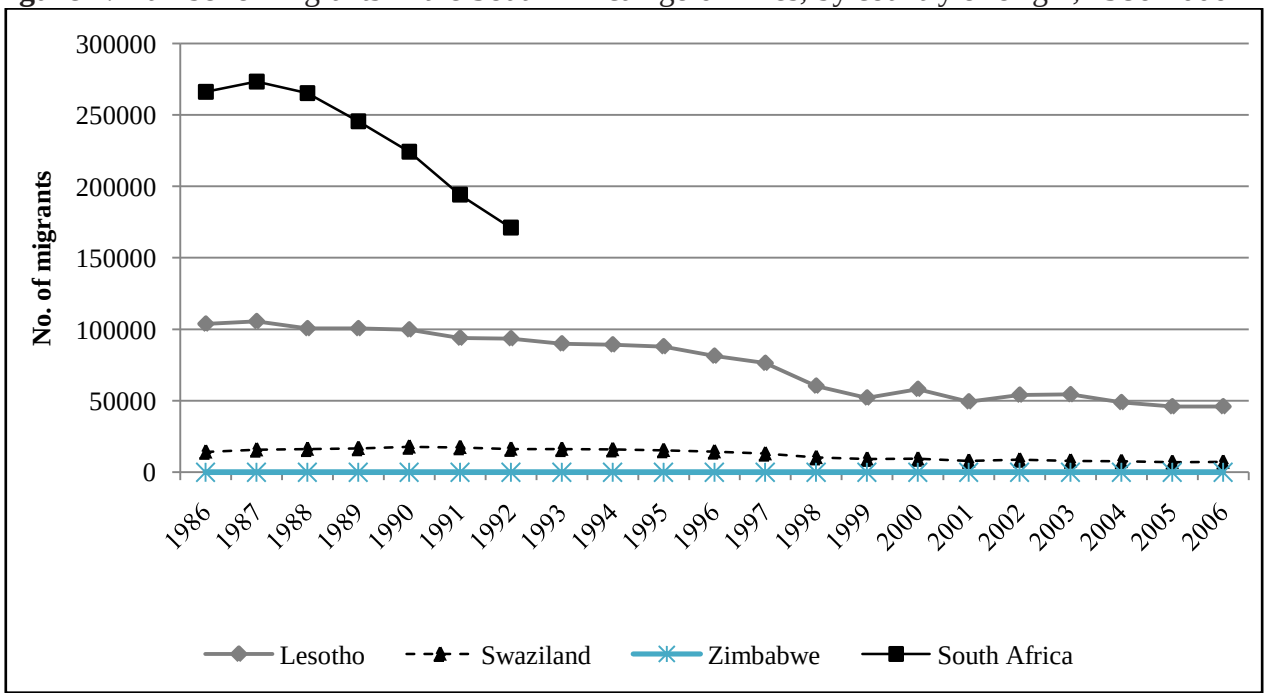
Figures

Figure 1: National HIV Prevalence in Africa



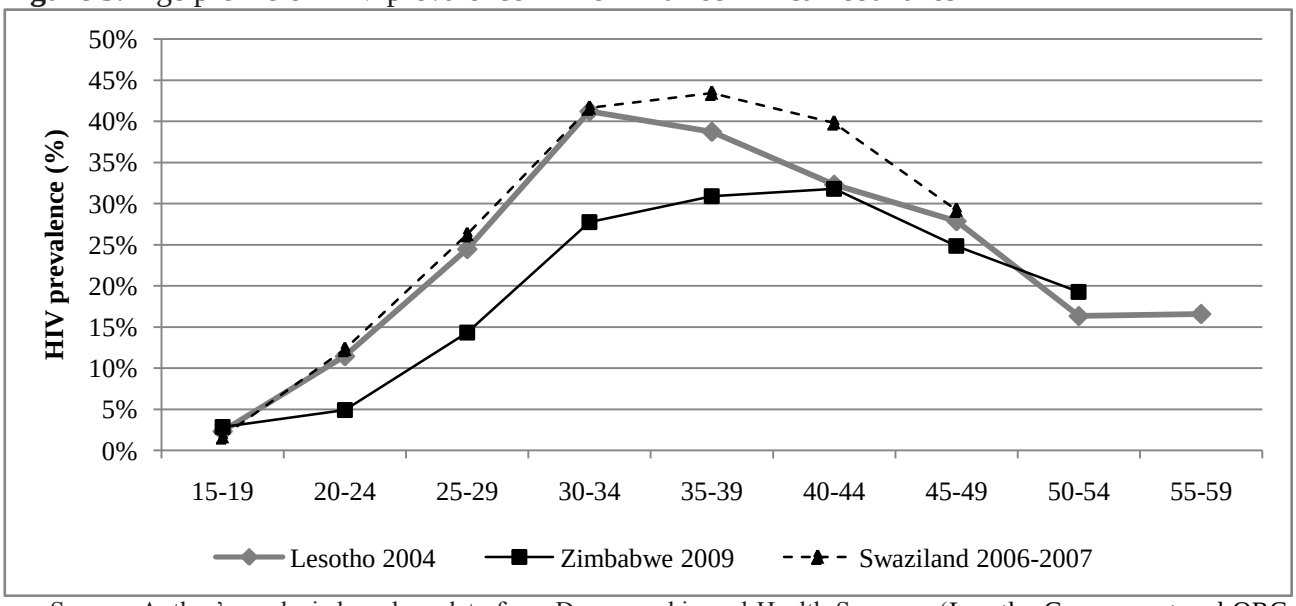
Source: CIA World Factbook, 2010. The year of HIV prevalence estimate is 2009 for all the countries.

Figure 2: Number of migrants in the South African gold mines, by country of origin, 1986-2006



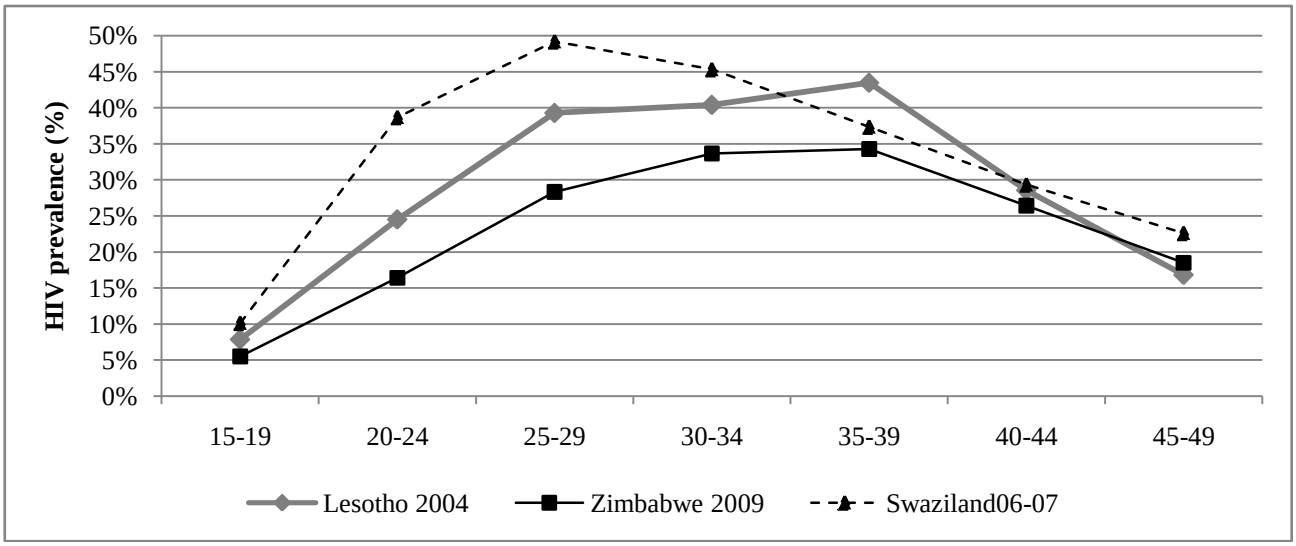
Source: Crush (1995) for data from 1986 to 1989. Crush, William, Peberdy (2005) for data from 1990 to 2006. Data on the number of miners in South Africa are not available after 1993.

Figure 3. Age profile of HIV prevalence in men in three African countries



Source: Author's analysis based on data from Demographic and Health Surveys (Lesotho Government and ORC Macro, 2005; Swaziland Government and ORC Macro 2008; Zimbabwe Government and ORC Macro, 2007).

Figure 4. Age profile of HIV prevalence in women in three African countries



Source: Author's analysis based on data from Demographic and Health Surveys (Lesotho Government and ORC Macro, 2005; Swaziland Government and ORC Macro 2008; Zimbabwe Government and ORC Macro, 2007).

Tables

Table 1: HIV prevalence, by type of job (%)

	Pooled Sample				**Lesotho (2004)**				**Swaziland (2006-07)**				**Zimbabwe (2005-06)**			
	Men		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*	
	Respondent's job	*HIV +*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV +*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV+*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV+*	*Partner's job*	*HIV +*
Miners/quarrymen	3.97	21.7	14.89	35.0	3.18	40.0	31.58	36.0	2.82	20.0	6.53	43.3	4.95	18.0	5.78	30.0
Clerical	1.61	25.1	2.52	25.7	1.54	30.0	1.71	29.0	2.00	34.3	3.67	29.1	1.41	14.4	2.67	23.2
Other skilled manual	14.19	27.1	21.8	33.4	11.01	31.9	17.50	37.4	17.7	33.6	30.7	38.1	13.41	19.6	21.26	29.4
Services	6.78	23.5	8.37	30.5	3.25	27.4	4.50	34.4	10,49	23.1	11.76	38.1	6.01	23.2	9.94	25.5
Agriculture employees	4.71	18.8	4.62	24.9	9.3	13.5	6.50	16.2	4.29	28.3	5.23	33.0	3.16	16.8	3.01	26.7
Professional/managerial	5.90	20.2	9.17	28.2	2.82	24.0	3.63	27.5	7.74	23.2	15.0	25.6	6.03	16.7	11.0	29.7
Unskilled manual	1.10	20.4	1.92	32.8	3.47	21.2	4.01	34.4	---	----	----	----	0.81	19.1	1.12	30.7
Household and domestic	3.02	15.3	2.66	29.4	--	--	0.42	18.1	---	----	--	--	5.85	14.8	4.52	29.8
Agriculture self-employed	15.45	16.0	17.72	20.3	10.05	20.1	18.53	22.9	7.02	26.2	5.47	38.5	22.44	13.6	21.26	17.7
Salesmen, shop assistants	4.11	21.8	6.08	32.0	2.47	32.0	3.80	38.0	5.43	25.2	7.10	50.3	3.99	16.5	7.36	23.7
Unemployed	38.55	10.2	5.15	31.7	52.66	13.6	7.35	28.0	42.51	9.5	14.41	33.4	30.76	8.0	0	0
Don't know/Don't answer	0.60	29.0	5.09	8.0	---	---	---	---	---	---	---	---	1.19	29.0	10.7	23.8

Notes: The pooled sample includes Lesotho, Swaziland and Zimbabwe. Table reports the fraction of respondents in each occupation, for jobs with more than 10 observations each. Source: Author's analysis based on data from Demographic and Health Surveys (Lesotho Government and ORC Macro, 2005; Swaziland Government and ORC Macro 2008; Zimbabwe Government and ORC Macro, 2007).

Table 2: Summary statistics

	All sample		Lesotho (2004)		Swaziland (2006-07)		Zimbabwe (2005-06)	
Variable	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
HIV positive	.191	.292	.185	.260	.195	.313	.140	.207
	(.393)	(.453)	(.389)	(.439)	(.396)	(.464)	(.347)	(.405)
Abstinence in the last year	.341	.300	.274	.298	.386	.304	.355	.343
	(.474)	(.456)	(.446)	(.457)	(.487)	(.460)	(.478)	(.474)
Extra marital intercourse in the last year[a]	.230	.095	.298	.127	.165	.039	.085	.007
	(.421)	(.294)	(.457)	(.333)	(.371)	(.194)	(.278)	(.086)
Condom Use	.332	.150	.185	.181	.493	.374	.245	.084
	(.474)	(.439)	(.389)	(.385)	(.500)	(.484)	(.430)	(.278)
Condom use with spouse[a]	.187	.142	.084	.093	.281	.227	.074	.033
	(.390)	(.349)	(.278)	(.290)	(.449)	(.419)	(.263)	(.180)
Condom use not with spouse[b]	.278	.163	.201	.111	.341	.239	.188	.051
	(.448)	(.369)	(.401)	(.314)	(.474)	(.426)	(.391)	(.219)
Miner	.029	--	.0318	--	.028	--	.049	--
	(.169)	--	(.175)	--	(.165)	--	(.215)	--
Partner miner	--	.230	--	.315	--	.065	--	.057
	--	(.421)	--	(.464)	--	(.247)	--	(.230)
Age	27.82	28.06	29.75	28.20	26.52	27.85	27.90	27.6
	(10.72)	(9.67)	(12.47)	(9.94)	(9.50)	(9.75)	(10.53)	(9.39)
Age squared	893.22	884.62	1041.0	894.31	793.76	871.17	889.6	853.8
	(698.02)	(595.20)	(869.44)	(6.144)	(573.51)	(599.01)	(678.3)	(576.64)
Partner age	--	38.17	--	36.94	--	40.41	--	37.45
	--	(11.21)	--	(10.37)	--	(10.80)	--	(11.79)
Primary Education	.422	.421	.540	.607	.343	.328	.294	.333
	(.490)	(.493)	(.498)	(.488)	(.474)	(.469)	(.455)	(.471)
Secondary Education	.385	.418	.237	.355	.485	.509	.632	.594
	(.486)	(.493)	(.425)	(.478)	(.499)	(.499)	(.482)	(.490)
Tertiary Education	.064	.041	.025	.013	.090	.079	.055	.029
	(.245)	(.198)	(.157)	(.116)	(.287)	(.270)	(.228)	(.168)
Urban	.325	.318	.248	.274	.346	.309	.342	.359
	(.468)	(.466)	(.432)	(.446)	(.475)	(.462)	(.474)	(.479)
Durable goods	1.56	1.43	.992	1.01	2.37	2.22	1.74	1.79
	(1.61)	(1.56)	(1.19)	(1.19)	(1.74)	(1.75)	(1.68)	(1.78)
Catholic	.156	.2057	.449	.444	.049	.048	.103	.103
	(.363)	(.404)	(.497)	(.496)	(.216)	(.215)	(.304)	(.304)
Protestant	.324	.454	.482	.544	.205	.278	.330	.480
	(.468)	(.497)	(.499)	(.498)	(.404)	(.448)	(.473)	(.499)
No Religion	.185	.048	.065	.008	.187	.0407	.251	.085
	(.396)	(.215)	(.246)	(.092)	(.390)	(.197)	(.433)	(.279)
# times slept away from the hh	.500	--	2.09	--	8.79	--	3.927	--
	(.112)	--	(4.163)	--	(14.37)	--	(10.39)	--
Husband not living in the hh	---	.423	--	.452	--	.372	--	.267
	--	(.494)	--	(.498)	--	(.483)	--	(.442)
Observations	6,953	12,082	2,797	7,095	4,156	4,987	7,175	8,907

Notes: Standard deviation in parenthesis. The pooled sample includes Lesotho and Swaziland. The variable condom is equal to one if condom was used in the last intercourse and zero otherwise for Swaziland and Zimbabwe, while it assumes value one if it was used in the last intercourse for women and if was the most recent contraceptive method for men in Lesotho. (a) Sample of currently married individuals. (b) Sample of single and married individuals who reported extra marital sex in the last intercourse. Source: Authors ' analysis based on data from Demographic and Health Surveys (Lesotho and ORC Macro, 2005; Swaziland and ORC Macro, 2008, Zimbabwe and ORC Macro 2007).

Table 3. HIV prevalence and mining status: pooled regressions: Swaziland and Lesotho

Dependent Variable=1 if HIV positive						
	Men				*Women*	
	Full Sample	*Age 30-44*	*Current Married*	*Current Married, Age 30-44*	*Full Sample*	*Age 25-39*
	(1)	(2)	(3)	(4)	(5)	(6)
Miner	0.041	0.153*	0.078	0.208**		
	[0.041]	[0.084]	[0.083]	[0.098]		
Partner miner					0.086***	0.102***
					[0.026]	[0.035]
Partner age					0.003***	0.002**
					[0.001]	[0.001]
Age	0.072***	0.107	0.056***	0.190**	0.054***	0.030
	[0.004]	[0.068]	[0.011]	[0.080]	[0.007]	[0.031]
Age sq.	-0.001***	-0.001*	-0.001***	-0.003**	-0.001***	-0.001
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
Primary Education	0.006	0.026	0.001	-0.032	-0.082***	-0.082*
	[0.019]	[0.035]	[0.032]	[0.038]	[0.027]	[0.044]
Secondary Education	-0.015	0.031	-0.037	-0.051	-0.059	-0.032
	[0.022]	[0.043]	[0.038]	[0.041]	[0.050]	[0.041]
Tertiary Education	-0.115***	-0.159**	-0.145**	-0.188***	-0.151***	-0.150***
	[0.021]	[0.076]	[0.072]	[0.060]	[0.035]	[0.056]
Urban	0.043***	0.022	0.042	0.019	0.128***	0.120***
	[0.017]	[0.045]	[0.033]	[0.062]	[0.030]	[0.025]
Durable goods	-0.010*	0.003	-0.012	0.008	-0.012**	-0.028**
	[0.005]	[0.014]	[0.011]	[0.017]	[0.005]	[0.011]
Catholic	0.027	0.043*	0.066***	0.022	0.019	-0.009
	[0.017]	[0.023]	[0.024]	[0.023]	[0.021]	[0.027]
No religion	-0.012	0.014	0.031	0.054	0.106	0.107
	[0.021]	[0.029]	[0.038]	[0.034]	[0.089]	[0.13]
Country dummies	yes	yes	yes	yes	yes	yes
Observations	3298	1015	1475	729	2622	1377
Pseudo R sq.	0.143	0.016	0.025	0.022	0.051	0.025

Notes: Table shows marginal effects calculated at the mean from probit coefficients. For dummies, marginal effect is calculated for discrete change from 0 to 1.* denotes significance at 10 percent level, ** at 5 percent level, *** at 1 percent level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. Estimated coefficients in columns 5 and 6 refer to the sample of currently married or cohabiting women.

Table 4: HIV prevalence and mining status in Lesotho and Swaziland : analysis by country

Dependent Variable=1 if HIV positive

	Lesotho						*Swaziland*					
	Men				*Women*		*Men*				*Women*	
	Full sample	*Age 30-44*	*Curr. Married*	*Curr. Married, Age 30-44*	*Full sample*	*Age 25-39*	*Full sample*	*Age 30-44*	*Current Married*	*Current Married, Age 30-44*	*Full sample*	*Age 25-39*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Miner	0.097*	0.260**	0.145**	0.280**			-0.101	0.211	-0.085	0.106		
	[0.049]	[0.106]	[0.068]	[0.113]			[0.070]	[0.141]	[0.103]	[0.158]		
Partner miner					0.051*	0.070*					0.110*	0.192**
					[0.027]	[0.039]					[0.066]	[0.085]
Partner age					0.003	0.001					0.004*	0.0037
					[0.002]	[0.003]					[0.002]	[0.002]
Age	0.061***	0.086	0.047***	0.231	0.073***	-0.004	0.108***	0.222	0.091***	0.258	0.002	0.049
	[0.004]	[0.140]	[0.012]	[0.17]	[0.011]	[0.068]	[0.013]	[0.161]	[0.032]	[0.19]	[0.016]	[0.073]
Age sq.	-0.001***	-0.001	0.001***	-0.003	-0.001***	-0.000	-0.001***	-0.002	-0.001***	-0.003	-0.000	-0.001
	[0.000]	[0.002]	[0.000]	[0.002]	[0.000]	[0.0011]	[0.000]	[0.002]	[0.000]	[0.002]	[0.000]	[0.001]
Primary Edu	-0.003	0.050	-0.023	0.011	-0.004	-0.009	0.025	0.025	0.049	-0.022	-0.089**	-0.093
	[0.019]	[0.058]	[0.035]	[0.067]	[0.068]	[0.120]	[0.050]	[0.081]	[0.067]	[0.093]	[0.045]	[0.065]
Secondary Edu	-0.014	0.038	-0.035	-0.002	0.030	0.042	-0.023	0.018	-0.041	-0.070	-0.099**	-0.048
	[0.023]	[0.076]	[0.046]	[0.086]	[0.072]	[0.121]	[0.047]	[0.078]	[0.064]	[0.089]	[0.047]	[0.068]
Tertiary Edu	-0.094***	-0.023	-0.097	-0.043	0.011	-0.112	-0.153***	-0.146	-0.150**	-0.151	-0.18***	-0.132
	[0.031]	[0.231]	[0.101]	[0.220]	[0.131]	[0.181]	[0.046]	[0.098]	[0.073]	[0.111]	[0.052]	[0.081]
Urban	0.056**	0.024	0.090**	0.030	0.080**	0.101**	0.023	0.001	-0.023	-0.015	0.152***	0.130***
	[0.022]	[0.063]	[0.043]	[0.074]	[0.032]	[0.047]	[0.029]	[0.054]	[0.043]	[0.062]	[0.038]	[0.049]
Durable goods	-0.004	0.024	-0.001	0.033	0.001	-0.013	-0.017*	-0.016				
	[0.007]	[0.025]	[0.016]	[0.029]	[0.011]	[0.017]	[0.009]	[0.019]				
Catholic	0.027*	0.037	0.072**	-0.004	0.024	0.004	-0.039	-0.055	-0.072	-0.059	-0.087	-0.128
	[0.016]	[0.050]	[0.031]	[0.057]	[0.023]	[0.036]	[0.064]	[0.111]	[0.094]	[0.12]	[0.084]	[0.099]
No religion	-0.025	-0.123	-0.023	-0.146	0.242	0.208	-0.001	-0.002	0.068	0.046	0.071	0.087
	[0.029]	[0.085]	[0.061]	[0.111]	[0.161]	[0.26]	[0.034]	[0.061]	[0.054]	[0.074]	[0.075]	[0.093]
Observations	2215	422	935	317	1584	754	1083	393	540	287	1038	623
Pseudo R sq.	0.153	0.024	0.044	0.041	0.050	0.012	0.049	0.023	0.039	0.024	0.081	0.049

Notes: Table shows marginal effects calculated at the mean from probit coefficients For dummies, marginal effect is calculated for discrete change from 0 to 1.* denotes significance at 10 percent level, ** at 5 percent level, *** at 1 percent level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. Estimated coefficients in columns 5-6 and 11-12 refer to the sample of currently married or cohabiting women.

Table 5: Abstinence and non-marital sexual relationships during the last 12 months

Dependent Variable=	*1 if no sexual intercourse in the last year*		*1 if extramarital sexual intercourse in the last year*	
	Men	*Women*	*Men*	*Women*
	Full Sample	*Full Sample*	*Curr. Married*	*Full Sample*
	(1)	(2)	(3)	(4)
Miner	-0.098***		0.001	
	[0.035]		[0.048]	
Partner miner		-0.014*		0.019*
		[0.007]		[0.009]
Partner age		0.001*		0.001**
		[0.001]		[0.001]
Age	-0.077***	-0.006**	0.002	0.012***
	[0.003]	[0.003]	[0.008]	[0.003]
Age sq.	0.001***	0.000**	-0.000	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Primary Education	-0.009	0.003	0.021	-0.050***
	[0.021]	[0.014]	[0.027]	[0.020]
Secondary Education	0.005	-0.008	0.016	-0.067***
	[0.023]	[0.015]	[0.033]	[0.016]
Tertiary Education	0.0123	0.005	-0.003	-0.061***
	[0.040]	[0.028]	[0.050]	[0.016]
Urban	-0.045***	-0.006	0.044*	0.031***
	[0.015]	[0.008]	[0.025]	[0.012]
Durable goods	-0.005	-0.013***	-0.001	-0.019***
	[0.005]	[0.003]	[0.009]	[0.004]
Catholic	-0.025*	0.003	0.068***	0.029***
	[0.015]	[0.007]	[0.025]	[0.009]
No religion	0.017	-0.006	-0.00442	0.017
	[0.024]	[0.023]	[0.035]	[0.041]
Country dummies	yes	yes	yes	yes
Observations	4071	4799	1828	4747
Pseudo R sq.	0.223	0.051	0.031	0.060

Notes: Table shows marginal effects calculated at the mean from probit coefficients. For dummies, marginal effect is calculated for discrete change from 0 to 1. * denotes significance at 10 percent level, ** at 5 percent level, *** at 1 percent level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. Estimated coefficients in columns 2 and 4 refer to the sample of currently married or cohabiting women.

Table 6: Condom use, with spouse and not with spouse

Dependent Variable=1 if use condom						
		Men			*Women*	
	Full Sample	*With Spouse*	*Not with Spouse*	*Full Sample*	*With Spouse*	*Not with Spouse*
	(1)	(2)	(3)	(4)	(5)	(6)
Miner	-0.121***	-0.060	-0.170***			
	[0.033]	[0.032]	[0.060]			
Partner miner				-0.037***	-0.036***	-0.078
				[0.011]	[0.011]	[0.089]
Partner age				-0.003***	-0.003***	-0.004
				[0.0009]	[0.0009]	[0.003]
Age	0.015***	0.011	0.043***	0.021***	0.021***	0.032
	[0.004]	[0.008]	[0.007]	[0.005]	[0.005]	[0.024]
Age sq.	-0.0003***	-0.0002*	-0.001***	-0.0003***	-0.0003***	-0.000
	[0.0000]	[0.0001]	[0.0001]	[0.000]	[0.000]	[0.000]
Primary Education	0.068***	0.036	0.089***	0.009	0.016	-0.008
	[0.023]	[0.027]	[0.035]	[0.024]	[0.027]	[0.076]
Secondary Education	0.207***	0.111***	0.244***	0.076***	0.082***	0.109
	[0.028]	[0.036]	[0.040]	[0.027]	[0.032]	[0.084]
Tertiary Education	0.256***	0.124**	0.429***	0.044	0.059	-0.023
	[0.049]	[0.057]	[0.070]	[0.041]	[0.047]	[0.141]
Urban	0.089***	0.088***	0.075***	0.058***	0.049***	0.087*
	[0.017]	[0.022]	[0.024]	[0.013]	[0.013]	[0.050]
Durable goods	0.008	0.006	0.021**	0.008**	0.009**	0.0079
	[0.005]	[0.007]	[0.008]	[0.004]	[0.004]	[0.018]
Catholic	-0.011	-0.008	-0.022	-0.015	-0.019*	0.071
	[0.016]	[0.022]	[0.023]	[0.011]	[0.011]	[0.087]
No religion	-0.001	0.005	-0.057*	-0.044	-0.019	-0.163**
	[0.023]	[0.030]	[0.032]	[0.029]	[0.039]	[0.067]
Country dummies	yes	yes	yes	yes	yes	yes
Observations	3843	1498	2302	4516	4191	305
Pseudo R sq./R sq.	0.144	0.139	0.200	0.089	0.143	0.006

Notes: Table shows marginal effects calculated at the mean from probit coefficients. For dummies, marginal effect is calculated for discrete change from 0 to 1. * denotes significance at 10 percent level, ** at 5 percent level, *** at 1 percent level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. The dependent variable is equal to one if condom was used in the last intercourse and zero otherwise for Swaziland, while it assumes value one if condom was used in the last intercourse for female and if condom was the most recent contraceptive method for men in Lesotho. Column 2 includes the sample of currently married men. Estimated coefficients in columns 4 and 6 refer to the sample of currently married or cohabiting women.

Table 7. HIV, abstinence, fidelity and condom use, controlling for the presence of the partner in the household

Dependent Variable:	*1 if HIV positive*				*1 if abstinence in the last year*		*if extramarital sexual intercourse in the last year*		*1 if condom use*		*1 if condom use with spouse*	
	Men	*Men 30-44*	*Women*	*Women 25-39*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Miner	0.033	0.153*			-0.096***		0.005		-0.119***		-0.059	
	[0.041]	[0.087]			[0.035]		[0.045]		[0.033]		[0.033]	
Partner miner			0.087***	0.095**		-0.017**		-0.006		-0.044***		-0.044***
			[0.028]	[0.038]		[0.007]		[0.009]		[0.012]		[0.012]
# of times away from the HH in the last year	-0.001	-0.001			-0.004***		0.003***		-0.001		-0.001	
	[0.001]	[0.001]			[0.001]		[0.000]		[0.001]		[0.001]	
Husband living elsewhere			0.002	0.018		0.012*		0.057***		0.021**		0.008
			[0.019]	[0.028]		[0.006]		[0.008]		[0.010]		[0.009]
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	3249	993	2604	1365	4010	4771	1800	4719	3783	4490	1484	4171
Pseudo R sq.	0.113	0.017	0.043	0.020	0.246	0.056	0.091	0.145	0.123	0.112	0.151	0.164

Notes: Table shows marginal effects calculated at the mean from probit. For dummies, marginal effect is calculated for discrete change from 0 to 1. * denotes significance at 10 percent level, ** at level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. Controls include: age, age sq., dummies for education (prim status, durable goods, partner's age, country dummies. Columns 7, 8, 11 include the subsample of currently married respondents. Estimated coefficients for women refer to the sample of currently

Table 8. Are miners or migrant miners more likely to get HIV? The case of Zimbabwe

Dependent Variable=1 if HIV positive						
	Men				*Women*	
	Full Sample	*Age 30-44*	*Current Married*	*Current Married, Age 30-44*	*Full Sample*	*Age 25-39*
	(1)	(2)	(3)	(4)	(5)	(6)
Miner	-0.001	0.007	-0.016	0.030		
	[0.037]	[0.065]	[0.047]	[0.069]		
Partner miner					-0.012	-0.003
					[0.034]	[0.049]
Partner age					0.002*	0.001
					[0.001]	[0.001]
Age	0.059***	-0.024	0.057***	-0.035	0.052***	0.007
	[0.006]	[0.069]	[0.013]	[0.072]	[0.009]	[0.049]
Age sq.	-0.001***	0.000	-0.001***	0.001	-0.001***	-0.000
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
Primary edu	-0.055	-0.130	-0.095	-0.201**	0.078	0.026
	[0.049]	[0.095]	[0.066]	[0.099]	[0.052]	[0.097]
Secondary edu	-0.036	-0.113	-0.062	-0.180	0.059	0.028
	[0.055]	[0.110]	[0.073]	[0.130]	[0.050]	[0.095]
Tertiary edu	-0.090**	-0.143	-0.094	-0.190**	0.006	-0.072
	[0.043]	[0.091]	[0.066]	[0.083]	[0.076]	[0.100]
Urban	0.00375	0.086*	0.011	0.059	0.038	0.075*
	[0.024]	[0.048]	[0.035]	[0.051]	[0.027]	[0.042]
Durable goods	-0.000	-0.019	-0.006	-0.013	-0.009	-0.019*
	[0.006]	[0.013]	[0.009]	[0.014]	[0.007]	[0.011]
Catholic	0.049	0.072	0.049	0.058	-0.018	-0.011
	[0.030]	[0.053]	[0.041]	[0.056]	[0.028]	[0.042]
No religion	0.072***	0.066*	0.067**	0.077*	0.006	0.011
	[0.021]	[0.037]	[0.027]	[0.040]	[0.030]	[0.045]
District dummies	yes	yes	yes	yes	yes	yes
Observations	2107	873	1440	776	2125	1203
Pseudo R sq.	0.078	0.014	0.024	0.015	0.023	0.007

Notes: Table shows marginal effects calculated at the mean from probit coefficients. For dummies, marginal effect is calculated for discrete change from 0 to 1. * denotes significance at 10 percent level, ** at 5 percent level, *** at 1 percent level. Robust standard errors in parentheses are corrected for clustering of the residuals at the cluster level. Constant not displayed. Estimated coefficients in columns 5 and 6 refer to the sample of currently married or cohabiting women.